Systematic notes on *Leptostigma setulosum* (Rubiaceae)

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Abstract

Morphological and other features of the single New Zealand species of *Leptostigma*, *L. setulosum* (Hook. f.) Fosberg are described, and the affinities of this genus with *Nertera* and *Coprosma* are commented on. The three genera are maintained; in particular, the distinctness of *Leptostigma* is supported by the chromosome number count of 2n=40 for *L. setulosum*, compared with 2n=44 of *Nertera* and most species of *Coprosma*.

Keywords: *Leptostigma setulosum* - *Nertera* - *Coprosma* - Rubiaceae - taxonomy - New Zealand flora

Introduction

This article assesses the taxonomic characters of the single New Zealand representative of the Southern Hemisphere genus *Leptostigma* Arnott (Rubiaceae-Anthospermeae-Coprosminae). This species, *L. setulosum* (Hook. f.) Fosberg, has been known in New Zealand botanical works as *Nertera setulosa* Hook. f. (e.g., Allan 1961).

Leptostigma was revised by Fosberg (1982), who placed in it four species of South America together with *L. setulosum* and the very similar *L. reptans* (F. Muell.) Fosberg of Australia. The genus is said to be distinct from *Nertera* in its long tubular corolla and also in the fruit being dry and with a well-developed and persistent calyx; the two genera together are supposed to differ from *Coprosma* in their herbaceous habit and bisexual flowers (Hooker 1873, Fosberg 1982).

These distinctions were challenged by Heads (1996), who emphasized the existence of the 'herbaceous' and bisexual *Coprosma talbrockiei* Moore & Mason and the 'woody' *Nertera* species of the Tristan da Cunha Islands, and he placed all these plants into an enlarged *Coprosma* (128 spp.), though keeping *Nertera* (13 spp.) and *Leptostigma* (6 spp.) in their own sections.

Observations, mainly of *Leptostigma setulosum* and the New Zealand *Nertera* species, are given below. The question as to whether *Leptostigma* and *Nertera* might be best within *Coprosma* is not fully resolved here, but it is suggested that it is reasonable to maintain the three genera, as they have rather different facies. To anticipate: *Leptostigma* comprises wiry-stemmed herbs with wind-pollinated, bisexual flowers and dry, persistent fruit; *Nertera* comprises rather fleshy herbs with small, possibly insect-pollinated, bisexual flowers, and succulent quickly-maturing fruit; *Coprosma* comprises woody plants with wind-pollinated, unisexual flowers and succulent slowly-maturing fruit.

In the following notes, therefore, the name *Coprosma* is used in its restricted sense.

Materials and Methods

The observations are based mainly on study of material in New Zealand herbaria. During 1996-7 observations of live plants of some of the species referred to here were also made. These plants were either growing naturally or were in

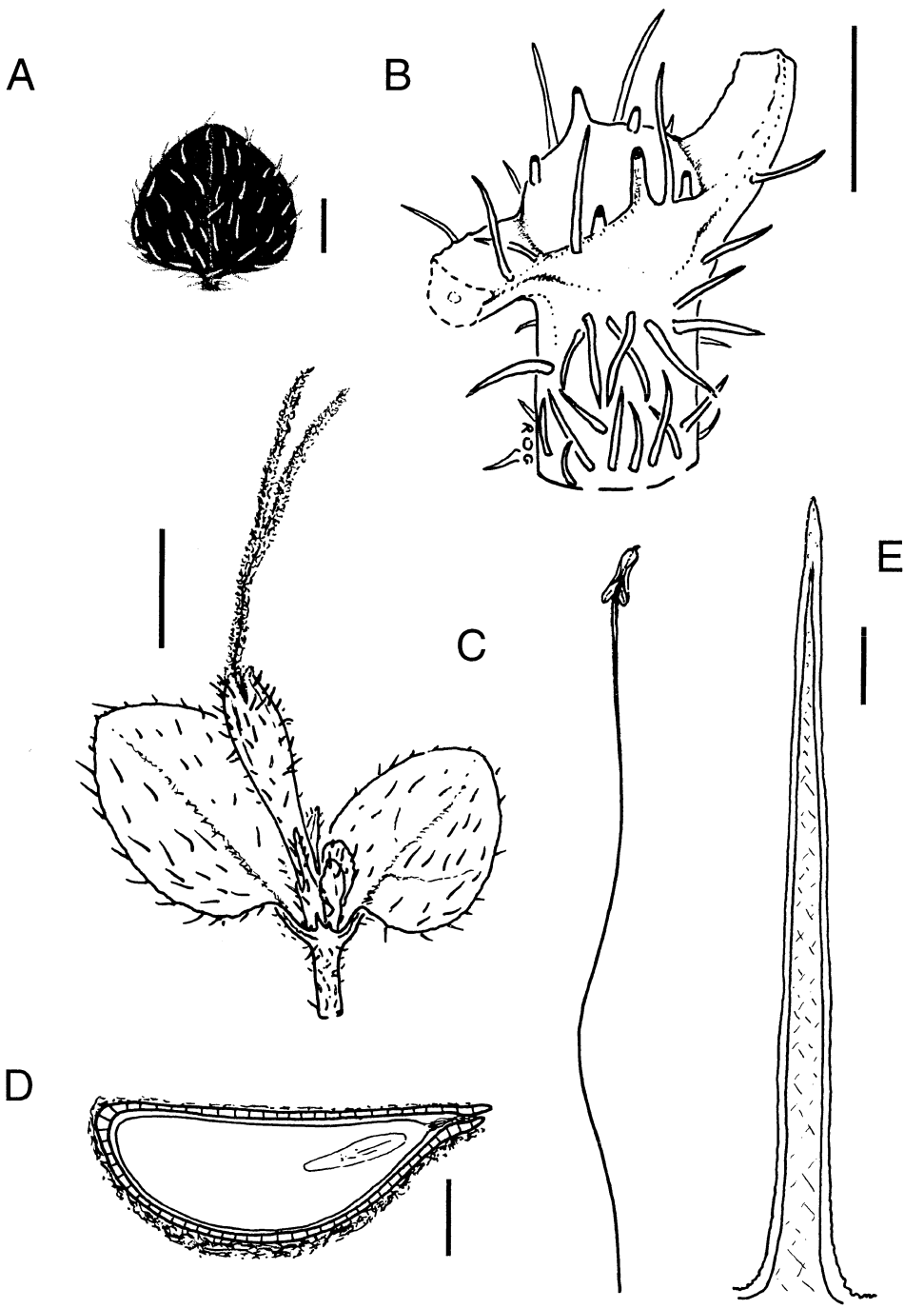

Figure 1 *Leptostigma setulosum*. A, Leaf blade; B, stipules; C, flowering shoot (female phase), with a stamen on right; D, pyrene, transverse longitudinal section; E, hair. Scale bars in A-D equal 0.5 mm, and in E 0.1 mm.

cultivation in various places in the Auckland region.

Anatomical investigations on wood anatomy and hair morphology were made using hand-sections stained with chlor-zinc-iodine or phloroglucinol-HCl.

Results and Discussion

Some of the features of *Leptostigma setulosum* noted below are shown in Fig. 1.

Habit

Leptostigma setulosum and the New Zealand *Nertera* species have a small amount of woody (secondary) growth. *Nertera ciliata* Kirk is the most robust of these plants, having stems that occasionally reach almost 5 mm in diameter, with a stele of c. 3 mm diameter. The xylem of *N. ciliata* is without annual rings and appears to be without rays. The inner cortex of very old stems eventually develops a rather weak periderm.

The stem of *L. setulosum* is relatively slender (to c. 1.5 mm diam.), with a stele much like that of *N. ciliata* and an early-developing periderm in the outer cortex. The cortex itself sometimes also lignifies, which increases the stem's rather wiry nature.

The shoot of a specimen of *Coprosma talbrockiei* (AKU) was examined at a point where the leaves were beginning to wither. The stem here, after rehydration, measured 1.4 mm in diameter. The stele, of 0.4 mm diameter, apparently lacked annual rings and rays; a periderm is present. This species, therefore, would seem to be as 'herbaceous' as *N. ciliata* and *L. setulosum.* However, it would be premature to regard this lack of woodiness as a synapomorphy, if only because a check needs to be made for wood in the as yet unknown basal and underground parts of *C. talbrockiei* (*cf.* Moore & Mason 1974 p. 140). (The other three members of sect. *Moorei*, to which *C. talbrockiei* belongs, are all woody mat-forming alpines).

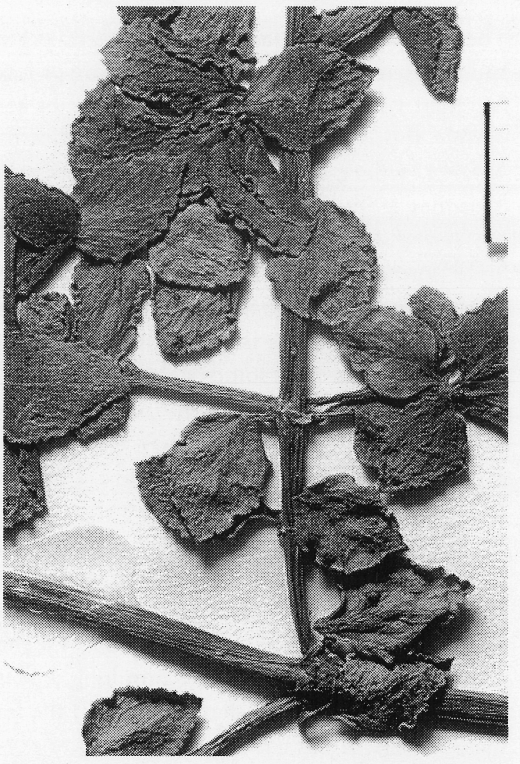

Figure 2 *Nertera assurgens* s.l. Herbarium sheet CHR 275505. Scale bar 1 cm.

Material from the Tristan da Cunha Islands, named as *N. assurgens* Thouars and *N. holmboei* Christophersen, was examined (CHR, O, WELT). These specimens are vegetative but are sufficiently alike as to suggest that they are conspecific. The taxon seems to represent a derivative of *N. depressa,* with large leaf blades (to c. 13 mm long), the margins of which are undulate and strongly cartilaginous (Fig. 2). The largest stem any of the sheets bear is (after rehydration) only 2.75 mm in diameter, with a stele of 1 mm diameter. Periderm is lacking. It is not appropriate then to term these plants 'woody' (by comparison with *N. ciliata*, for example) though it is reasonable to suppose that in their robust habit they might be exhibiting the phenomenon of 'insular gigantism'.

Hairs

The hairs of *L. setulosum* are unicellular, acute and finely roughened, and become more or less flattened when dry (Fig. 1E). They do not resemble those of any New Zealand species of *Nertera*, where there is a range of structure (Gardner 1999).

Flowers

The elongate nature of the corolla tube, characteristic of *Leptostigma*, is also seen in *Coprosma* in the male flowers of some of the small-leaved, prostrate species. This is most notable in *C. perpusilla*, where the tube may reach 12-15 mm long (see Eagle 1986 figure 196, as *C. pumila*). In the others - *C. atropurpurea* (Ckne. & Allan) Moore, *C. petriei* Cheesem., *C. nipophila* Orchard, *C. nivalis* Oliver, *C. pumila* Hook. f.) (Orchard 1986, Eagle 1986), and also in *C. talbrockiei* (Moore and Mason 1974), the tube varies from about 3 to 11 mm long, but is still considerably longer than the tube of the female flowers. It has a distinctly cylindrical portion at its base. The elongate tube can reasonably be regarded as an adaptation for raising the stamens up into the air, to facilitate wind-dispersal of their pollen.

Correlated in the wind-pollination syndrome in *L. setulosum* is the presence of long anthers, which (as in *Coprosma*), are elastically dehiscent and release their pollen cleanly. In addition, the stigmas of *L. setulosum* are clothed with hair-like papillae, which reach 0.2 mm long and are at least as long as those of any New Zealand coprosma (R. O. Gardner unpubl. data). The flowers are strongly protogynous (Fig. 1D). (In his generic description Fosberg (1982) says that the flowers of *Leptostigma* are probably protandrous, but this appears to be a slip, since in the description of *L. pilosum* (Benth.) Fosberg he notes the protogynous character).

The flowers of the New Zealand *Nertera* species are bisexual and protogynous; the corolla is a short, rather broad funnel; the small anthers do not dehisce elastically; the stigmas are obscurely papillate. It is speculated that these plants may be insect- or splash-pollinated (and are probably also self-pollinated). They are unlike those of any particular species or group within *Coprosma*.

Bremer & Struwe (1982) claimed that *Nertera* differed from *Coprosma* by having stamens that are adnate to the corolla tube. I agree with Heads (1996) and with the authors cited by him, in denying this for the New Zealand *Nertera* species at least - their stamens are quite free, not fused even to the very base of the tube.

Pollen

The structure of the pollen grains of the relevant New Zealand taxa was described by Moar (1993). He stated that *Coprosma* and *Nertera* pollens could generally be distinguished by the latter being gemmate, but his descriptions (including that of *L. setulosum* pollen) suggest that there are no clear distinctions here.

Gardner (1975) recorded a number of *Coprosma* species as having bicellular ('binucleate') pollen grains at anthesis. *Leptostigma setulosum*, and *Nertera depressa*, *N. dichondrifolia*, and *N. scapanioides*, also have bicellular grains (R. O. Gardner pers. obs.).

Fruit

The fruit of *Leptostigma* is distinguished from that of *Nertera* and *Coprosma* by its non-juicy character and (particularly from *Nertera*) by its persistent, erect and comparatively conspicuous calyx lobes (Fosberg 1982). As observed in *L. setulosum*, the fruit achieves full size in a matter of a few weeks in mid-summer, but remains green and firmly fleshy for months after that, only drying out during mid- to late winter. The 1.5 mm long calyx lobes are also green. Presumably then the fruit body and calyx are making a metabolic contribution to seed development. Even the seed-coat remains green until the fruit begins to dry off, a feature not noted by me in full-sized pyrenes of any of the New Zealand

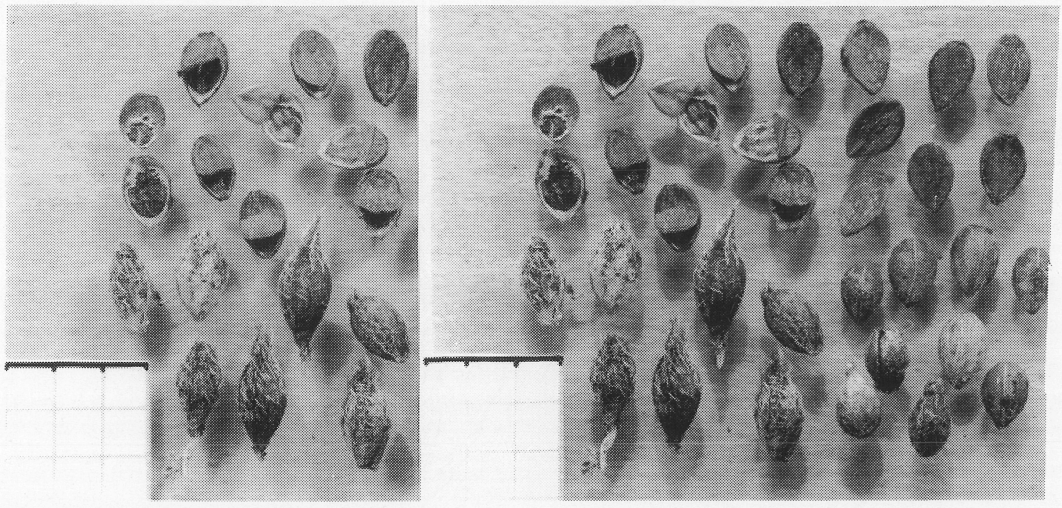

Figure 3 *Leptostigma setulosum*. Stereo-pair photographs showing fruit and pyrenes. Right hand photo shows: Upper left, pyrenes with base of ventral surface lifted (or removed) by dissection; upper right, pyrenes with intact ventral surface; lower left, more or less intact but 'weathered' fruit; lower right, pyrenes, dorsal aspect. Small squares of grid 0.2 mm wide (scale bar 0.6 mm long).

Nertera species.

Pyrenes, seeds

The fruits of *Leptostigma*, *Nertera* and *Coprosma* contain two planoconvex pyrenes, whose shape and texture varies from species to species only rather subtly (R. O. Gardner unpubl. data). In *Coprosma*, the lower third or so of the flat (ventral) face is typically differentiated as an heart-shaped or triangular operculum (sometimes called a valve, or germination lid). This is usually slightly different in colour or rugosity from the upper part, and lifts or detaches completely when the radicle emerges (see Moore & Irwin 1978, for an illustration of germination in *Coprosma crassifolia* Col.).

Heads (1996, p. 403) suggested that in *Nertera* the operculum might occupy the entire ventral face. However, in my manipulation of the pyrenes of the New Zealand *Nertera* species and *Leptostigma setulosum* I have not found it possible to raise the entire face above about halfway up the seed; where the marginal slits become obscure, the sides of the face always begin to tear obliquely (Fig. 3). Moore & Irwin (1978) illustrate germination in *N. balfouriana* Ckne, where the basal slits yield to allow the lower end of the pyrene to gape slightly, and a similar process takes place in *Nertera scapanioides* (R. O. Gardner pers. obs.) and presumably in the other species of this genus.

Heads (1996) also noted that the opercula of two small-seeded *Coprosma* species, *C. pumila* and *C. petriei*, are 'barely differentiated', and he suggested that the disappearance of a well-defined operculum (i.e. the lack of a transverse, straight or heart-shaped line of dehiscence) may simply be a function of fruit size. The seeds of both these species though, and also the similar-sized ones of *C. talbrockiei* (Fig. 4), can be made to yield a fairly well-defined operculum on dissection. Anatomical study and germination tests would seem to be necessary to advance this line of enquiry.

The illustrations of Hooker (1852, pl. XXVIII) of the pyrenes of *Nertera dichondrifolia* (A.Cunn.) Hook. and *Leptostigma setulosum*, and his note here (1852 p. 112) for the latter species, '*embryone parvo*', might be taken as indicating a significant difference in the size

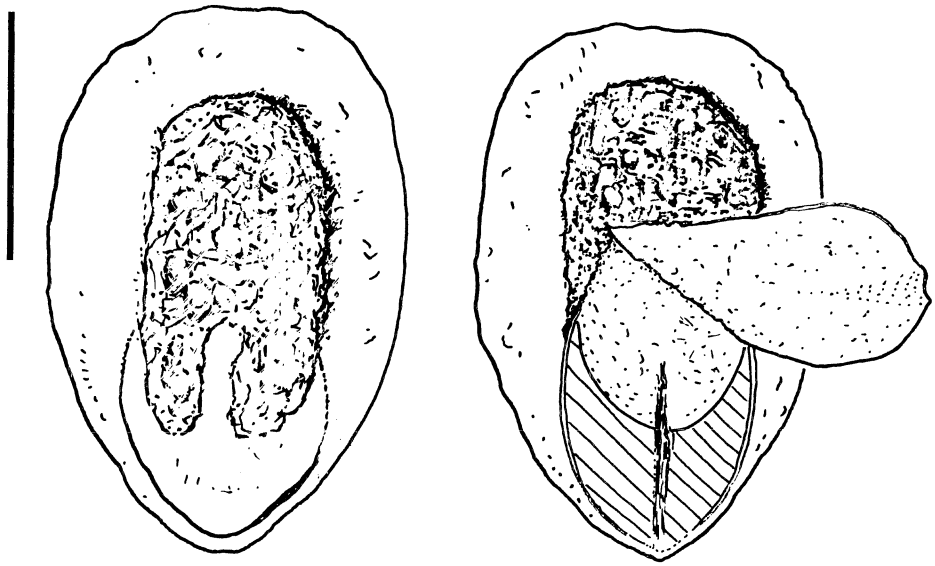

Figure 4 *Coprosma talbrockiei*. Pyrenes, ventral aspect. Left: intact pyrene, the central part of the ventral surface rugulose, the operculum comparatively smooth and with its submarginal slits showing at base. Right: pyrene with operculum raised by dissection, the ventral surface beginning to tear beyond the operculum. Scale bar 1 mm.

of their embryos. In the former species the embryo is shown to be about two-thirds as long as the seed, and this proportion holds for the other New Zealand *Nertera* species too (Hooker 1852, R. O. Gardner pers. obs.). The embryo of *L. setulosum* is confirmed as being proportionately much smaller than those of the New Zealand *Nertera* species (R. O. Gardner pers. obs., Fig. 1D). However, the South American species *L. pilosum* apparently has a relatively large embryo (Hooker 1872, pl. 1123), like those of the *Nertera* species.

Chromosome number

The base chromosome number of *Coprosma* (incl. *C. talbrockiei*) and *Nertera* is x=22 (Hair 1963; Beuzenberg 1983; Beuzenberg 1988). However, for *Leptostigma setulosum* Hair (1963) recorded counts (from 7 clones) of n=20, and the corresponding mitotic number (2n =40) has been obtained by M. I. Dawson (pers. comm.) from a clone of cultivated material. Until all the leptostigmas have their chromosomes counted, this divergence in number seems sufficient reason for keeping the genus separate from *Coprosma* and *Nertera* (*cf.* Hair 1966, p. 571).

Synopsis

This brief study finds no support for the merging of *Leptostigma* with *Nertera*, nor for the sinking of these two genera into *Coprosma*. The idea that *Coprosma talbrockiei* and its relatives in sect. *Moorei* might be a link between the genera in some way (Moore & Mason 1979, Heads 1996), or that *Leptostigma* is 'just a herbaceous *Coprosma*' perhaps too with affinity to *C. talbrockiei*, in my opinion results from underrating the likelihood that the herbaceous habit and bisexual flower may well have evolved several times in tribe Anthospermeae. It is true that there are characters of sect. *Moorei*, such as the bisexuality of the flower and the non-sheathing stipules, that are also found in *Leptostigma* and *Nertera*, but other features of the section, such as the acuminate or needle-tipped leaves, and their ternate arrangement (*C. talbrockiei*), are quite lacking.

An elaboration of the differences noted between *Leptostigma setulosum* and the New Zealand *Nertera* species is given below. Note that some features of *L. setulosum* have been recorded in other members of that genus by Fosberg (1982), e.g., the unicellular hairs which flatten when dry, the numerous colleters around the stipule rim, and the way in which a new vegetative shoot quickly develops at the base of a flower, to place the developing fruit into a pseudoaxillary position.

Leptostigma setulosum

Erect or mat-forming perennial herb, stems wiry in lower parts (cortex eventually lignifying); new shoots regularly arising from one of the axillary buds at the base of the flower, these buds leafy at flowering and elongating as the fruit forms; hairs unicellular, acute, finely striate (× 400), slightly roughened (notably so in stem hairs), ± flat when dry; stipules running into petiole margins, not at all sheathing (but sheathing in *L. arnottianum* Walp.), several large, finger-like, dark-tipped colleters borne on rim and inner surface; stomata lacking from upper surface of lamina; flowers bisexual, protogynous, parts in 4s or 5s; calyx lobes c. 1.5 mm long; corolla tube to c. 9 mm long, expanded in distal third; stamens becoming long-exserted, anthers comparatively long (2 mm), apiculate, sagittate at base, twisted after anthesis (± explosively dehiscent); style branches fused towards base, exserted (stigmatic) parts with delicate elongate obtuse-tipped papillae to c. 0.2 mm long; fruit persisting green on the stem for c. 6-8 months, mesocarp green (photosynthetic), gradually drying, the calyx lobes green, persistent, erect; pyrene opening from the base by marginal slits that sometimes reach slightly more than half-way up the sides and which do not incurve at their upper ends; embryo non-photosynthetic, c. ⅓ as long as seed.

Nertera (New Zealand species)

Creeping perennial herbs forming appressed to loose low mats, stems herbaceous, remaining fleshy and photosynthetic for some time, new shoots usually tardy in developing from axillary buds at the base of the developing fruit (but sylleptic development sometimes in *N. depressa*); hairs unicellular or multicellular, smooth; stipules running into petiole margins, or meeting above petiole base in a V, or forming a low sheath there, colleters lacking (but stipule apex ± dark-glandular); stomata sometimes present on upper side of lamina; flowers bisexual, protogynous, parts in 4s; calyx lobes minute; corolla campanulate or broadly funnelform (tube to 1.25 mm long in *N. villosa*); stamens inserted at corolla mouth, the anthers short (to c. 0.5 mm long), oblong, not conspicuously apiculate or sagittate, not elastically twisting at anthesis (pollen not shed freely); style branches free or fused towards base, comparatively short and fleshy, with minute papillae on exserted part; fruit juicy, red to yellow, calyx rim and lobes obscure (but not shed); pyrene opening by short basal marginal slits that do not incurve at their upper ends; embryo non-photosynthetic, c. ⅔ as long as seed.

Representative Specimens

Coprosma talbrockiei

nr Boulder Lake, *J.E. Braggins*, 1966, WELT, & AKU 11685 [voucher for stem anatomy]

Hope Range, *E.A. Brown*, 1986, AKU 19442 [pyrene morphology]

Leptostigma arnottianum

[Chile], *coll. ign.*, AK 77924

Leptostigma reptans

Australia, *Albrecht 5074*, 30 Nov 1972, AK 226600

Leptostigma setulosum

cult. Auckland University, *R.O. Gardner 8229*, 1 Jan 1997, AK 234049 [stem anatomy, floral and fruit anatomy, pollen nuclear number] and CHR 512353 [chromosome count

of M.I. Dawson]

Nertera assurgens

s. l. Tristan da Cunha, *E. Christophersen 458*, 30 Dec 1937, WELT

Tristan da Cunha I., *Y. Mejland 1725*, 15 Mar 1938, CHR 272360

Nightingale I., *E. Christophersen 2103*, 4 Feb 1938, CHR 272357

Nertera ciliata

Reefton, *R.O. Gardner 8347*, 20 Mar 1997, AK234048 [stem anatomy]

Nertera villosa

Matukituki Valley, *E.K. Cameron 8702*, 7 Jan 1997, AK 230841 [stamen position]

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